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SUBSTITUTE SPECIFICATION
FISCHER ET AL., W1.2278 PCT-US

CROSS-REFERENCE TO RELATED APPLICATIONS

[001] This patent application is the U.S. national phase, under 35 USC 371, of PCT/EP2005/050138, filed January 14, 2005; published as WO 2005/075197 A1 on August 18, 2005, and claiming priority to DE 10 2004 006 232.3, filed February 9, 2004, the disclosures of which are expressly incorporated herein by reference.

FIELD OF THE INVENTION

[002] The present invention is directed to a method and to a device for threading a material web. A threading device is conveyed along a threading path. The material web may be coupled to the threading device which is drivable by two spaced-apart drive motors.

BACKGROUND OF THE INVENTION

[003] Devices for threading a web are used in printing presses for conveying a leading end of a material web along a desired threading path through the printing press. This is necessary, for example, when threading in a web for use in a new production, or is always necessary whenever a material web has ripped during the printing process so that the leading end of the new material web cannot be pulled through the press, in the performance of a flying reel change. Moreover, in modern printing presses, it is possible for the material to be printed to be moved along different web travel paths in order to achieve different printing results. In the case of a changeover of the printing press, to perform a different printing process, the new material web must be pulled

along the appropriate threading or web feed path.

[004] DE 94 15 859 U1 discloses a device for threading a material web into a treatment station. The threading device, which is embodied as a belt, may be rewound from a first winding roll, located at the intake point of the treatment station, to a second winding roll, located at the outlet from the treatment station. The two winding rolls each have one drive in one preferred embodiment.

[005] In one embodiment, DE 197 24 123 A1 discloses a noncontinuous threading device that may be wound back and forth between two spool bodies, each of which is driven.

[006] A device for threading material webs in rotary printing presses is known from DE 22 41 127 A1. The threading device, which is embodied as a spring steel belt, may be conveyed through to the exit of the printing press along various threading paths, which path may be reconfigured by the use of switch points. Here, the threading device is driven by a driving wheel that is fixed in place, that engages in a positive manner with the threading device, and that pushes the threading device through the printing press along its entire length.

[007] EP 04 18 903 A2 discloses a device for threading a material web. A threading device is driven by a motor that is regulated based on data which is measured during the threading process. The regulation process operates to maintain a constant threading speed and/or a constant motor speed.

[008] DE 94 09 390 U1 discloses a device for threading a material web in which a

threading device is driven by a multi-phase motor. A portion of a transport path, which has already been travelled by the threading device,is detected by the use of sensors.

[009] Devices for threading a material web are known from WO 02/090 650 A2. A discontinuous threading device is driven by a drive in the region of a delivery area for the material web. In a first embodiment, this drive is regulated with regard to its speed, which may optionally be correlated with an independently driven aggregate speed of the machine. In a second embodiment, the drive is regulated with respect to a torque.

SUMMARY OF THE INVENTION

[010] The object of the present invention is directed to providing a method and a device for threading a material web.

[011] This object is attained by the provision of a threading device that can be conveyed along a threading path. A material web leading end is attachable to the threading device. The threading device is drivable by a first motor that is located in a web receiving area, and by a second motor that is located in a web delivery area. The first motor is controlled to run at a predetermined threading speed. The second motor is controlled with respect to a torque on the motor, which may also be predetermined.

[012] One advantage of the present invention lies in the fact that the machine, such as a web-fed rotary printing press may be started up in a faster and more secure manner after the threading process. The threading process occurs in a manner that is very protective of the material being threaded, in spite of the ability to operate at high threading speeds.

[013] In principle, the threading device may be embodied in a continuous fashion, such as, for example as a closed, belt-shaped material, that may be conveyed over a first driven roll located in the region of a beginning of the threading path and a second driven roll located in the region of an end of the threading path.

[014] However, it may also be advantageous for the threading device to be embodied in a noncontinuous fashion, with each of its ends being disposed on a spool or reel body such that it may be wound from a first spool or reel body, in the region of a beginning of the threading path, to a second spool or reel body in the region of the end of the threading path. In so doing, however, both ends of the threading device remain connected with their respective spool or reel body.

[015] In accordance with one preferred embodiment of the present invention, the threading device is driven by a first, driving spool or reel body in the region of the beginning of the threading path and a second driving reel body in the region of the end of the threading path. It is advantageous for these drives to be able to be drivable in two rotational directions for use in winding and unwinding the threading device.

[016] An adjustable electric motor is used to drive the spool or reel body which is located on at least the end of the threading path. The spool or reel body may thus be driven, in a regulated manner, with various rotation speeds and/or motor speeds. Preferably, the drives of both spool bodies are embodied as being adjustable in terms of their motor speed and/or an existing torque. By appropriate measurement of the infeed speed of the threading device, such as by using measurement points or by a

detection of the winding or unwinding angle on the spool body, the infeed speed of the threading device may be calculated and, by properly regulating the electric motor, a constant supply speed can be adjusted for the threading device. By detecting an existing torque, such as, for example, an electrical output, the existing torque may be determined. Acertain torque may be maintained or a maximum torque may be monitored. Depending on the given requirements, the respective electric motor is then appropriately adjusted with regard to either a speed, such as, for example, a frequency or motor speed or output.

[017] During the threading process, in one particularly advantageous embodiment of the present invention, the drive in the region of the end of the threading path, such as, for example, in the region of the superstructure of the printing press, is operated with the speed of the threading device or the electric motor speed being regulated, while the drive in the region of the beginning of the threading path, such as, for example, in the region of the reel changer is operated with respect to a torque, such as, for example, to maintain a constant retaining torque. In this manner, an even threading process is made possible and a particular tension of the web is made certain during the material web threading process. This process, through the regulation of both motor speed and torque, prevents so-called “bags” from forming in the web travel path, due to too low of a tension, or prevent a dancer roller, which may be located in the web travel path, from being loaded with a too widely deviating web tension. In the latter case, when the printing machine was started, for example, extremely high deviations from target values,

and therefore high amplitudes of regulating systems would occur. "Incorrect" web tensions in the startup phase, such as too high tensions or too low tensions, due to "bag" formation could then easily lead to web tears, or at least to an unnecessarily high amount of web distortion or maculation.

[018] In a further embodiment, the process and device for threading a web, in accordance with the present invention are in an active connection to a machine controller and/or to a web tension regulator, which is provided for operation. In other words, simply by correctly threading the web, during the original installation of the components that influence web tension, such as, for example, the dancer rolls, it is possible to provide a machine that is ready for operation.

[019] In principle, the use of a plurality of sensors is conceivable for use in measuring the supply speed of the threading device. A particularly simple construction results when the effective circumference of the spool or reel body, with which the threading device is unwound, as well as the rotational speed of the spool or reel body is measured or is provided as a curve. The effective circumference of the spool or reel body is understood as the value that results from adding the interior circumference of the spool or reel body itself to the circumference of the layers of the threading device which are still wound on the reel body. By evaluating these two measured values, the linearly oriented feeding path and the time-dependent linearly oriented feeding speed of the threading device may be easily determined. Subsequently, by the use of appropriate regulation, the rotational speed of the spool body may be regulated to a target value. It

is also conceivable for a control curve, which can be provided in the supporting software, to contain the corresponding dependence of the target rotational speed on the number of rotations of the reel body that have occurred.

BRIEF DESCRIPTION OF THE DRAWING

[020] One preferred embodiment of the present invention is shown in the sole drawing figure and is described in greater detail in the following.

[021] The sole drawing shows a schematic side elevation view of a printing press with a device for use in threading a material web in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[022] In a web processing and/or finishing machine 01, such as, for example, in a printing press 01, for treating a web and/or material web, such as, for example, for printing on a paper web, a device is provided for threading a leading end of the web into the machine 01, by the use of which device, a leading end of the web may be conveyed from a beginning of a web threading path to an end of the web threading path. Optionally, either before or after this machine-fed path, a manual path may connect further through the machine.

[023] By way of example, the printing press 01, which is depicted only schematically in the sole drawing, includes an assemblage 02, which is embodied as a printing unit 02, and depicted here with two double printing groups or four printing groups, as well as an assemblage 03, which is embodied as a reel changer 03, and a folding funnel or folding

hopper assembly 04. Connected to the folding funnel 04 is a folding apparatus 05 that continues to process the material web. In operation, the material web, which is not specifically shown, runs from the reel changer 03 through one or more printing units 02, and then optionally is processed by the use of a superstructure, which is not specifically shown and which is typically providing a longitudinal cutting device and a turning or reversing deck, and is further processed by the use of the folding funnel 04. A device for threading the material web is provided in order to thread the web mechanically onto at least one section of this type of a material web path.

[024] In an advantageous first preferred embodiment of the present invention, a frontal region of the machine, in which a web of material to be threaded may be connected to a threading device 06, is referred to in the following discussion as the receiving area. A rear region of the machine, in which the threaded web is separated from the threading device 06, is referred to in the following discussion as the delivery area. The device has one spool or reel body 07; 08, at each of the receiving area and the delivery area, and onto each of which reel bodies 07; 08 the threading device 06 may be wound or unwound, by rotation of the spool or reel bodies.

[025] In an embodiment which is not specifically shown, the threading device 06 may be continuous, or embodied as a loop which, instead of being wound on spool or reel bodies 07; 08, circulates, in the receiving area and the delivery area around a transport reel or roller. It is preferable for these transport reels to be driven in the same manner as the spool or reel bodies 07; 08, which are described in greater detail below, i.e.,

regulated or controlled by rotational speed or torque. In order to reduce slippage, such transport reels or rollers may work together with pressure rolls or rollers, for example.

[026] The receiving area is preferably located in the vicinity of the reel changer 03 such that the web may be guided by the threading device 06 directly after the unwinding of the web from its reel at the changer reel. Fundamentally, the delivery area may be disposed at any desired point along the web travel path up to, and including after the folding funnel 04. In the advantageous embodiment shown in the sole drawing, the delivery area and thus the delivery area spool or reel body 07 is disposed after the last printing unit 02 through which the web passes, but before the folding funnel 04. If reversing rods are located in the superstructure, the delivery area may optionally be located even before these reversing rods, if the guidance system for the threading device 06 and the web are not constructed for moving the web around the reversing rods.

[027] It is advantageous for the entire web to be threaded, in a straight line, up to the folding funnel 04. Only after the web has been threaded should the longitudinal web slitting blade be placed in the superstructure and the new partial web to be pulled over the reversing rods. Here, the delivery area is located slightly before the entrance to the funnel.

[028] In the preferred embodiment shown in the sole drawing figure, the spool or reel body 07 is driven in the delivery area by a drive having a single motor 11, such as, for example, an electric motor 11, and in particular an alternating current motor that may be

regulated at least with regard to its speed. In a simpler preferred embodiment, there is only one control by the use of which, a target value $\acute{n}_{soll}$ for the motor speed or the frequency of the motor 11 is simply impressed into a control loop, without feedback. In an alternative embodiment, the motor 11 is controlled in that, using a provided target value, an internal control loop of the motor drive calculates a target value $\acute{n}_{soll}$ for the motor speed or frequency, so that the winding and unwinding speed of the threading device 06 is ultimately calculated by taking the winding radius of the reel 07 into account. Here, for example, an actual value of a measured angle speed, or of the number of rotations per unit time of a component or a motor is sent back to a drive regulator, which drive is not specifically shown.

[029] The target value $\acute{n}_{soll}$ for the motor speed and/or frequency that ultimately represents the threading speed is given to the motor 11 or to its drive control by a control device 12. This control device 12 has, for example, a frequency converter 13 and a control and/or calculation unit 14, and in particular has a servo control unit 14, which is embodied as a Servo PLC 14, for example. With reference to a target value of a given threading speed v_{soll}, logic integrated into the Servo PLC 14, or into an additional logical component then calculates the target frequency and supplies it to the motor 11 by way of the frequency converter 13. In a simple preferred embodiment, the threading speed v_{soll} may be directly and manually provided to the control device 12, such as, for example, by way of an input medium or by a corresponding interface on the control device 12. In a preferred embodiment, the entry of the threading speed v_{soll} is

made by the use of a higher-level control device 16, such as, for example, by a machine control 16. This guarantees synchronization between the speed of movement of the threading device 06 and at least components or assemblies 02; 03; 05 of the printing press 01, which interact with the web to be threaded, such as, for example, by coming into physical contact with it.

[030] By way of example, the sole drawing figure shows a rotary drive 17 for the printing unit 02 and/or a rotary drive 18 for the reel changer 03 and/or a rotary drive 20 of the folding apparatus 05 in electrical or other similar signal connection with the machine control 16. The rotary drives 17; 18; 20 are preferably embodied to be mechanically independent from one another but are connected to one another electronically by way of the machine control 16. When a particular machine speed is entered, such as, for example, a particular threading speed for use in the threading operation is entered, the printing unit 02 and/or the reel changer 03 and, optionally, other assemblies in the printing press 01 as well as the control device 12 of the device for threading the web receive speed-relevant target values that are correlated with each other and that guarantee synchronization of the speeds. For example, the unrolling speed at the reel changer 03 or the circumferential speed at the printing cylinder and the web speed are synchronized with each other.

[031] The movement control of the subordinate drives 17; 18; 20, or target value input preferably follows a conductivity value of a so-called electronic guide axis Φ. The position of the guide axis Φ may either be oriented on one of the assemblies 02; 03; 05

of the printing press 01, such as, for example, on the folding apparatus 05, and may provide the input values to the remaining assemblies 02; 03. Alternatively, the guide axis Φ may rotate freely, optionally depending on calibration on one of the assemblies 02; 03; 05, such as, for example, on the folding apparatus 05, and, in subsequent operation, may supply the positions to all of the assemblies 02; 03; 05. A winding speed of this rotating guide axis Φ then corresponds to a predetermined machine speed, such as, for example, a setting for a "threading speed for automatic threading" or a setting to print with a motor speed or a product output that may be predetermined. As a result, during the threading process, due to the machine control 16, and/or due to the guide axis Φ, the movements of at least one moving assembly 02; 03 that interacts with the web, such as, for example, the printing unit 02 and/or the reel changer 03 and the threading device 06 are synchronized. The target value input of the threading speed v_{soll} into the control device 12 is preferably aimed at a selected machine speed.

[032] When the device is embodied with a threading device 06 that is to be wound and unwound, and with a drive to wind or unwind one or both spool or reel bodies 07; 08, the changing winding radius of the reel body must be taken into account when entering the target value $\acute{n}_{soll}$ into the motor 11. Although fundamentally, this radius may be detected on a continual basis by arranging at least one sensor on the spool or reel body 07; 08, the radius is preferably calculated using the base diameter of one or of both spool or reel bodies d07; d08, the number of winding layers or rotations u_{0X} on one or both of the spool or reel bodies d07; d08 and the thickness d06 of the threading device

06. If, with respect to a tension in the threading device 06 that must be maintained, a negligible lead must be provided in the motor speed n_v, this must be added in as well. A current target value $\acute{n}_{soll}$ for motor speed may, in principle, be calculated using the following equation

$$\dot{n}_{soll} = \frac{v_{soll}}{\pi * (d0X + (2 * d06 * u_{0X}))} + \dot{n}_v ,$$

where 0X = 07 or 08 and where, depending on the location of the arrangement of a sensor 19, such as, for example, a resolver 19, detecting the number of rotations or angular degrees that have been passed through, a transformation from one spool body 07; 08 to the other must occur.

[033] In the sole drawings figure, in order to count the number of rotations, the resolver 19 is shown in solid lines in the region of the spool or reel body 07 and in dashed lines in the region of the spool or reel body 08.

[034] From the target value for the threading speed v_{soll}, the base diameter of one or of both of the spool or reel bodies 07; 08, the number of winding layers or rotations u_{0X} on one or on both of spool or reel bodies d07; d08 and the thickness d06 of the threading device 06, a corresponding signal for the motor 11, for use in keeping the threading

speed constant, is then generated in the control and/or calculation unit 14 and in the frequency converter 13 and is sent to the motor. In a threading operation, the motor 11 in the delivery area is thus regulated, by its motor speed, to maintain a constant threading speed v. The expression $d0X + (2*d06*u_{0X})$ then represents a current, calculated diameter D0X (D07, D08) after u_{0X} rotations.

[035] In contrast, a motor 21, such as, for example, an electric motor 21, and in particular an asynchronous motor 21, driving the spool body 08 in the receiving area, is driven during at least the threading operation in a torque-limiting manner. This is accomplished using the servo control of the control and/or calculation unit 14. The logic mentioned above for use in calculating a target frequency for the motor 11 as well as for the servo control for the motor 21 may also be embodied in separate components.

[036] In an advantageous operational mode of the present invention, a desired tightening of the belt in the threading operation occurs by actuating the motor 21 in the receiving area with a constant retaining momentum. In principle, the motor 21 runs in a rotational direction which is opposite to the unwinding direction. However, motor 21 becomes effectively forced to run in the rotational direction for unwinding by the force of the stronger motor 11.

[037] In the threading operation, the threading device 06 is thus pulled by the motor 11 and the spool or reel body 07 in a circumferential speed-controlled manner from the reel changer 03 to the delivery area , such as, for example to the folding funnel 04, with the motor 11 being fed by the frequency converter 13 which, in turn, receives a calculated

target value $\acute{n}_{soll}$ for the frequency from the control and/or calculation unit 14, which depends on the current machine speed, or on the target value of the threading speed v_{soll} and on the calculated diameter D07; D08 of the spool body 07; 08 used for calculation. The motor 21 in the receiving area, such as, for example near the reel changer 03 is actuated by the control and/or calculation unit 14. In the threading mode, for example, motor 21 receives a low offset engine speed in the direction opposite the unwinding direction. For example, by adjusting a target tension value $Z_{soll,e}$ for the threading process, by the use of an input device to the drive, the torque may be limited. The motor 21 is "overtaken" by the stronger, motor speed-controlled motor 11 and thus provides the desired belt tension in the threading device 06.

[038] During rewinding of the threading device 06, the delivery area motor 11 runs, for example, with an adjustable rewinding speed, such as, for example v = 26 m/min and the drive motor 21 in the receiving area runs at an increased speed, and at a constant torque in order to produce the belt tension. In such a rewinding operation, the delivery area drive motor 11 receives its target frequency value, such as, for example, the target value $\acute{n}_{soll}$, corresponding to the currently calculated diameter D07; D08 of the spool or reel bodies 07; 08 in the opposite direction. The receiving area drive motor 21 receives an adjustable speed, which is evaluated with a fixed diameter, such as, for example, with a fixed diameter of 220 mm for the empty drum. In addition, as in the threading process, it is preferable for an offset engine speed to be added in order to ensure a constant lead on the delivery area drive motor 11 and on its spool or reel body 07. By a

constant lead of the spool or reel body 08 and by the provision of an adjustable target tension value $Z_{soll,r}$ for the rewinding process, the desired belt tension is built up and maintained in rewinding operation.

[039] Maintaining a constant threading speed and, in particular, maintaining particular torques when threading, allows the web to be threaded in a manner such that the web, and the assemblies that influence the web tension reach, a state which already approximates the conditions required for starting the printing press 01. This is shown in the sole drawing figure by the example of adancer roller 22 which is circumscribed by the threading device 06. When the machine 01, which is embodied as a printing press 01, is in operation, the dancer roller 22 corrects an existing web tension, with respect to a selectable, constant web tension. This constant web tension may, for example, be provided and regulated by a web tension regulator, which here is integrated into the machine control 16. Once the target value has been appropriately adjusted during the threading process, and the torque on the threading device 06 has been maintained, threading is now possible without bag or web sag formation and/or without an undesired deflection of the dancer roller 22 occurring. This means that the threading process occurs with approximately correct path lengths and tensions. When the printing press 01 is started up later for production operation, the danger of web tears or of protracted fluctuations in regulation are reduced. In a further development of the present invention, a regulation of the web tension may have already been activated during the web threading process.

[040] While a preferred embodiment of a method and device for threading a web, in accordance with the present invention has been fully and completely described hereinabove, it will be apparent to one of skill in the art that various changes in, for example the specific structure of the threading device, the specific nature of the sensors and the like could be made without departing from the true spirit and scope of the present invention which is accordingly to be limited only by the appended claims.

WHAT IS CLAIMED IS: